CHAPTER 13

ENVIRONMENTAL CONTROLS

Many materials and situations aboard ship can damage personnel and the environment. Continued emphasis and direction on combating environmental pollution by federal agencies is contained in presidential executive orders and congressional legislation. All facilities owned by, or leased to, the federal government must be designed, operated, maintained, and monitored to conform to applicable air, water, and noise standards established by federal, state, and local authorities.

The Navy actively participates in a program to protect and enhance the quality of the environment. The Navy adheres to all applicable regulatory standards and initiates actions to conserve natural resources, protect historical and cultural properties, and prevent or control pollution caused by Navy facilities. This chapter contains information dealing with some of the more serious problems that threaten the environment. It also covers the controls that are used to reduce the risks.

HEAT STRESS

On board ship, certain kinds of working spaces may be hot and humid. Some examples of hot and humid spaces are firerooms (boiler rooms), sculleries with automatic dishwashing machines, and galleys.

Heat stress is the basic inability of an individual's body to cope with the effects of a high-temperature and high-humidity environment. When a person works in a hot, humid environment, such as a boiler, heat builds up within his/her body. When the body's capability to cool itself is exceeded, heat stress can occur. The human body tries to cool itself automatically through sweating. Sweating is the mechanism by which the body gets rid of excess heat through evaporation. The sweat evaporates, thereby cooling the body and reducing body temperature. Although the sweating mechanism is a normal body function, the sweating process depletes the body of water and salts and changes the body's chemistry. If liquid volume and salts are not replaced, several heat illnesses or injuries can occur.

HEAT CRAMPS

Heat cramps are simply painful muscle contractions or spasms. They are normally caused by the loss of body fluids through sweating. It is also possible for a person who is overheated to induce muscle cramps by drinking cold liquids too quickly or in large quantities. Heat cramps are often an early warning of heat exhaustion. If you ever experience heat cramps, go to a cooler place, drink plenty of cool (not cold) water, and massage the cramping muscles.

NOTE: Administering salt in any form, even in drinking water, is POOR health care for victims of heat cramps. The loss of body fluids through sweating results in a HIGHER concentration of salts within the body. If the body's heat load builds up, the muscles will absorb increased amounts of salts. This absorption causes the muscles to cramp.

HEAT EXHAUSTION

Heat exhaustion is a more serious threat to health than heat cramps. Heat exhaustion usually occurs when personnel work or exercise in hot environments. The body's sweating mechanism is overloaded and cannot cope with the heat buildup within the body. Since the blood flow is disturbed, the victim may feel dizzy, headachy, and nauseated. The signs and symptoms of heat exhaustion are similar to those of shock and should be treated as such. When a person suffers from heat exhaustion, the skin is gray in color and feels cold and clammy. To help the heat exhaustion victim, remove the victim to a cool area and loosen his/her clothing. You should apply cool wet cloths to the head, groin, and ankles and lightly fan the victim. If the victim is conscious, give him/her cool water to drink. If vomiting occurs, do NOT administer any more fluids. Transport the victim to a medical facility as soon as possible.

HEATSTROKE

Heatstroke is a less common but far more serious threat to health than heat exhaustion. In about 20 percent of heatstroke cases, heatstroke is fatal. In heatstroke, the sweating mechanism breaks down completely; the body is unable to rid itself of excess body heat. The body's temperature may rise as high as 105°F. Prolonged, high body temperatures can cause failure of the brain, kidneys, and liver.

The early symptoms of heatstroke are similar to those of heat exhaustion–headache, nausea, and dizziness. At first, the victim's breathing is deep and rapid; but, as the symptoms progress, breathing becomes shallow, almost absent. The skin appears flushed, dry, and very hot. The pupils are constricted to a pinpoint; the pulse is fast and strong. It is extremely important that you recognize the differences between heat exhaustion and heatstroke. HEATSTROKE IS A TRUE LIFE-AND-DEATH EMERGENCY.

The most important first-aid treatment for a heatstroke victim is to lower the victim's body heat. Move the victim to a cool place. Douse the victim with cold water. Remove as much of the victim's clothing as possible to allow free flow of air over the body to promote cooling. If the victim is conscious, give him/her cool water to drink. Transport the victim to a medical facility as quickly as possible.

So far, we have discussed heat-related problems and the first-aid treatment for heat stress. However, you will be much better off if you learn what you can do to prevent heat stress.

PREVENTION

In spaces where heat stress is likely to occur, it is difficult to lower temperatures. Therefore, preventing heat stress-related conditions is the goal. Monitoring conditions that bring about heat stress and controlling the crew's exposure to high-heat and high-humidity conditions reduces the chances of heat stress.

Some of the factors that cause heat stress are as follows:

- Unnecessary heat and humidity sources
- Steam leaks
- Damaged insulation

Report these types of conditions so they can be corrected. Vents and exhaust blowers should be adjusted to maintain proper air circulation.

On board ship, spaces are ventilated by ductwork connected to supply (intake) and exhaust blowers. These blowers (or fans) are driven by two-speed electric motors. Exhaust fans have a greater air-moving capacity than supply fans. Unless personnel are otherwise directed, supply and exhaust ventilation fans are set to the SAME speed. It is important that you understand the need to MAINTAIN FLOW. If you do not MAINTAIN FLOW, the following could happen to you. A watch stander in a hot space sets the supply blower to high speed and then stands under the outlet.

Usually, you can tell whether the speed of the vent blowers for a space is set correctly by how hard it is for you to open or shut the doors to the space. For example, if a door opens outward and it is hard to close, then the space has a POSITIVE pressure. This means that the supply vent is probably set on high speed, and the exhaust vent is set on low speed.

Another common problem with shipboard ventilation systems is improper care of system filters. Filters are installed at the intake of the supply blowers to prevent dust and dirt from entering the ship. Cleaning these falters is considered to be routine maintenance. If, however, filter cleaning is neglected or is poorly done, the temperature of shipboard working and living spaces increases because there is a reduced flow of coding air. Spaces considered to be heat-stress areas should contain a heat-stress monitor to measure the heat-stress conditions.

On an individual level, wear clothing so there is some air circulation between the clothing and your body. Whenever you perform heavy physical labor, eat lightly and take a rest period before resuming heavy exertion.

The Navy has established strict space environmental monitoring requirements for heat-stress conditions. These *heat-stress surveys,* together with strict exposure limit standard tables, control the amount of time a person may remain in certain high-temperature and high-humidity conditions before being REQUIRED to go to a cool place and rest. For more information about heat injury, you should refer to *Shipboard Heat Stress Control and Personnel Protection,* OPNAVINST 5100.20 (series), and *Navy Occupational Safety and Health (NAVOSH) program Manual for Forces Afloat,* OPNAVINST 5100.19 (series).

Heat illnesses and injuries are primarily caused by the loss of body fluids and salts. Preventing these illnesses and injuries centers on replacing body fluids and salts, monitoring the environment, and controlling exposure. For example, in a hot environment, fluids must be replaced ounce for ounce. Therefore, when you are sweating heavily, increase your water intake proportionately. Meals provide salts to replace those lost through sweating. Therefore, if you work in a high-heat and high-humidity environment, you should eat well-balanced meals at regular intervals, salted to taste. You should get at least 6 hours of sleep every 24 hours. Wear clean clothing made from at least 35 percent cotton. **Do NOT wear starched clothing. Do NOT**

drink commercially prepared electrolyte supplements in place of water. Do NOT take salt tablets unless specified by medical personnel. Do NOT drink alcoholic beverages, because alcohol depletes the level of fluids in the body.

Remember, the effects of heat stress are cumulative (add up). Once you have heat cramps, heat exhaustion, or heatstroke, you are twice as likely to experience a heat stress-related incident; your body has an increased sensitivity to heat. Your awareness of the factors that contribute to heat stress and their prevention, as well as your strict adherence to established exposure limits, will help prevent your becoming a victim of heat stress.

POLLUTION

Before understanding how pollution affects you personally, you must take a realistic look at pollution. Pollutants, whether airborne or waterborne, adversely affect the food chain and often are directly harmful to humans. As Navy personnel, our primary concern is to control the pollutants aboard ship to minimize the pollution risk to ourselves and the environment.

OIL AND CHEMICAL POLLUTION

Fuel oil and chemical cleaning solvents are often used aboard Navy ships, and the possibility exists for a spill. These pollutants collect in the ship's bilges. From the ship's bilges, the pollutants are pumped into a waste oil collecting can.

Oily wastes behave just as their definition suggests: an oily waste is any solid or liquid substance that, alone or in a solution, can produce a surface film or *sheen* when it is discharged in clean water. Most oily wastes are derived (come) from petroleum or have characteristics of petroleum products. Waste oil is an oily waste that cannot be reused by the ship, and it contains only small amounts of water. Any mixture that causes a sludge or emulsion to be deposited beneath the surface oil and chemical pollution of the water is considered to be an oily waste.

Oily wastes frequently present a shipboard pollution problem. (Refer to the *Naval Ships' Technical Manual (NSTM),* chapter 593.) Oily wastes derived from lubricating oils are caused by tank cleaning operations, leakage and drainage from equipment and systems, stripping from contaminated oil-settling tanks, and ballast water from fuel tanks of noncompensated fuel systems during the ship's defueling, refueling, or internal transfer operations.

You may think that if a small amount of oil is pumped overboard, it cannot really cause much damage. Or can it? Remember, oil is less dense than water. It floats on the surface of the water and is carried by the action of winds and tides. Oily wastes can contain appreciable amounts of volatile petroleum or fuel products. When these wastes are confined in spaces, such as tanks and bilge compartments, they become a source of floating flammables or vapors that are potentially hazardous to personnel and equipment. If these vapors collect in a confined area, such as a pocket underneath a pier, they could explode if exposed to an open flame, such as from a welding operation or from a spark from a grinding wheel. Remember, YOU might be the person who is operating the torch, welder, or grinding wheel.

Besides being harmful to the environment and to people, oil and chemical discharge is also against the law. The Oil Pollution Act of 1961 prohibits the discharge of oil and oily waste products into the sea within 50 miles (150 miles in some cases) of land. A more recent law, the Federal Water Pollution Control Act of 1970, prohibits the discharge of oil by any person or agency from any vessel or facility into the navigable waters of the United States inside the 12-mile limit. All oil spills or sheens within the 50-mile prohibited zone of the United States must be reported immediately.

Oil Spill Prevention

Shipboard oil pollution is controlled by the efficient use of the oily waste control system that is incorporated into your ship. Oil pollution control systems reduce oily waste generation, store waste oil and oily wastes, monitor oil and oily wastes, and transfer waste oil and oily wastes to shore facilities. Effective use of your ship's oil pollution control system depends on operators' knowledge of the ship's pollution abatement system. To use your ship's oil pollution control system effectively, operating personnel are trained and plans are made so that oil and oily waste are handled properly. Other requirements for your ship include ensuring that equipment functions properly and that bilges are kept dry and free of oil. The minimum use of detergents is recommended when bilges and equipment are cleaned. Also, always give proper attention to preventive maintenance requirements.

The best prevention method any vessel can use against oil or chemical pollution is not to discharge pollutants into the sea. However, spills do occur during refueling operations. For example, to keep a ship "on an even keel," fuel oil maybe transferred from one tank to

another. Fuel storage tanks are connected by pipes and valves, some of which discharge overboard. All it takes is ONE human error, ONE valve to be open or shut through a vent pipe, and your ship has ONE spill in progress. The simplest solution is to have the people who operate the system do so in a conscientious manner. The people who operate and maintain the pollution control equipment should always be professionally trained and fully qualified.

Oil Spill Removal

If an accident occurs and oil is spilled, your ship should take prompt action to contain the oil and clean it up. A quick reaction by your ship's trained crew results in containment and often collection of the entire spill without the assistance of shore-based personnel.

Every ship should have an Oil Spill Containment and Cleanup Kit (O. S. C. C. K). Instructions for its use can be found in *U.S. Navy Oil Spill Containment and Cleanup Kit, Mark 1,* NAVSEA 0994-LP-013-6010. This manual describes applicable safety precautions for the use of the kit.

The kit consists of various sizes of porous mats, boat hooks, grappling hooks, plastic bags, and an instruction book for their use. If there is a spill, these absorbent mats are used by ship's personnel to soak up the spilled oil. First, soak the porous mats in diesel fuel and wring them out, which causes the mats to soak up the oil instead of water. After they are prepared, throw the mats on the oil spill to soak it up. Then, retrieve the porous mats using the boat hooks and grappling hooks. Next, wring the oil out of the mats into suitable containers. Then, throw the mats back onto the oil spill to soak up more oil. After the oil spill is removed, store the porous mats in plastic bags for disposal at a shore-based facility.

Additionally, containment trawlers can be rigged around a ship in port anytime the ship is engaged in fueling activities. Trawlers are floating fences made up of linked, buoyant *pillows* that confine any spilled oil to the vicinity of the hull.

NOISE POLLUTION AND CONTROL

Another type of pollution, which is often not thought of as pollution, is noise. Prolonged exposure to loud noises is not only psychologically taxing but also a cause of hearing loss. Continued exposure to noise levels of 85 decibels (dB) or greater and impact or impulse noise of 140 dB can cause severe hearing loss. You need to be aware of this problem because spaces in the engineering department can easily have average

Figure 13-1.-Circumaural (Mickey Mouse) type of ear protection.

noise levels within the danger range. The Navy has implemented an occupational noise and hearing conservation program. The goal of this program is to eliminate all noise hazards to personnel.

Wherever possible, noise is being reduced by design and insulation. When there are no other practical means available, personal protective hearing devices MUST be worn. Furthermore, anyone who works in spaces where noise levels exceed 104 dB must wear a combination of insert-type ear plugs and circumaural-type *ear muffs* (fig. 13-1).

In addition, each person assigned to duties in designated hazardous noise areas are included in the hearing conservation program and receive the required hearing tests within 90 days of that assignment. This procedure serves to determine if a significant hearing loss has occurred. Hazardous noise areas are identified and labeled by either the ship's medical personnel or an industrial hygienist. Audiometric hearing tests are required annually to monitor ship's personnel who are exposed to noise hazards. (Refer to *Navy Occupational Safety and Health (NAVOSH) Program Manual,* OPNAVINST 5100.23 [series].

ASBESTOS POLLUTION AND CONTROL

The inhalation of asbestos fibers can, after a period of years, cause a crippling respiratory condition called *asbestosis.* Exposure to asbestos can also cause several forms of cancer. All personnel who work around asbestos, and who smoke, should be aware that their chance of contracting lung cancer is increased ninetyfold.

The most prevalent use of asbestos materials aboard ship is in the fabrication and repair of pipe and boiler insulation. The greatest hazard is present when asbestos particles (dust) are in the air.

In the interest of personnel safety, the Navy has implemented an asbestos control program. The objective is to eventually replace the asbestos insulating materials with nontoxic materials. In the meantime, the asbestos control program identifies asbestos hazards and implements stringent safety requirements to be followed by personnel working with materials that contain asbestos. Ship personnel are not authorized to remove or repair insulation containing asbestos, except in an operational emergency certified by the commanding officer. Repair and removal work should be referred to the local intermediate maintenance activity (IMA) or contractor.

As you know, the greatest danger from asbestos exists when particles of asbestos are in the air, such as during rip-out of old insulation. Rip-out is normally performed by shipyard personnel; however, you may have to enter a space where there are asbestos particles. If you are ripping out old insulation or staying in the space where rip-out is in progress, you MUST wear protective clothing, use a pressure-demand supplied-air respirator (fig. 13-2), and be formally trained on asbestos-handling procedures. After completing your tasks, you MUST proceed to the designated decontamination center to remove the coveralls and respirator and to take a shower. These precautions should remove any asbestos particles and prevent the spread of asbestos dust to other sections of the ship.

You should wet down contaminated disposable coveralls. Wet down is a procedure that reduces the possibility of dust being blown off of the coveralls. Then, dispose of the contaminated coveralls in heavy-duty plastic bags. Clearly mark the plastic bags with caution labels to warn personnel of the asbestos hazard.

Insulation materials other than asbestos pose health hazards. For additional information on safe working practices involving these materials, consult the *NSTM*, chapter 635. REMEMBER, where safety is concerned, take nothing for granted. Your actions can have a positive or negative effect on you and your shipmates.

Figure 13-2.-Disposable protective coveralls and type C respirator.

REFRIGERANTS AND SAFETY PRECAUTIONS

The refrigerants commonly used are fluids, and they are affected by heat, temperature, and pressure in a manner similar to water. Many different fluids are used as refrigerants; their selection is based on low boiling points and other desirable characteristics. The following refrigerants are the most commonly used on U.S. Navy ships:

R-11, trichlorofluoromethane. R-11 is a colorless liquid or gas. At room temperature, R-11 has a slight ethereal odor (smells like ether or dry-cleaning fluid, tetrachloroethylene).

R-12, dichlorodifluoromethane. R-12 is a colorless and odorless gas at room temperature. In high concentration, it has a slight ethereal odor.

NOTE: Dichlorodifluoromethane (formerly F-12), is now called R-12.

R-22, monochlorodifluoromethane. R-22 is a colorless and odorless gas, which, at room temperature in high concentration, has a slight ethereal odor.

R-114, dichlorotetrafluoroethane. R-114 is a colorless and odorless gas, which, at room temperature in high concentration, has a slight ethereal odor.

R-113, trichlorotrifluoroethane. R-113 is a heavy colorless liquid, which, at room temperature, has a slight ethereal odor. R-113 is only used as a solvent, degreaser, and flushing agent. It is not used as a shipboard refrigerant.

These refrigerants, liquid and vapor, are nonflammable and nonexplosive. Air mixtures of these refrigerants are not capable of producing a flame. The products of decomposition have a pungent odor and are very irritating in minute quantities. They give ample warning before dangerous concentrations are reached.

R-12, R-22, and R-114 are shipped under pressure in steel cylinders. R-11 and R-113 are normally shipped in drums, although some R-11 is shipped in cylinders for submarine use. The refrigerant cylinders are easily identified by their orange-colored bodies. In addition, the following markings are made on the cylinder to minimize the possibility of misidentification of the gas:

- The name of the gas is stenciled longitudinally on two diametrically opposite sides of the cylinder.
- A decal bearing the name of the gas may be attached to the shoulder of the cylinder 90 degrees from the stenciling.

WARNING

Do not smoke, braze, or weld when refrigerant vapors are present. Vapors decompose to phosgene, acid vapors, and other products when exposed to an open flame or a hot surface.

The following safety precautions and warnings apply to all of the refrigerants listed in the previous paragraphs.

- Exposure to large concentrations of fluorocarbon refrigerants can be fatal. Vapors displace air (oxygen) in a space and result in asphyxia. In high concentrations, these vapors have an anesthetic effect, causing stumbling, shortness of breath, irregular or missing pulse, tremors, convulsions, and death. Fluorocarbon refrigerants and solvents should, therefore, be treated as toxic gases.
- Initial adverse anesthetic effects of R-113 can be experienced at much lower levels than those of other refrigerants, even though all refrigerants listed here have a threshold limit value (TLV) of 1,000 parts of refrigerant per million parts of air (ppm).
- Personnel overcome by inhalation of fluorocarbon vapors may develop cardiac problems. Remove exposed personnel to fresh air immediately. If breathing has stopped, apply artificial respiration. **Do not permit affected personnel to exert themselves or to exercise.**

TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed for an 8-hour day, 40 hours per week without adverse effects. In addition to the precautions previously stated, there are other safety measures that should be followed. A few of these methods and precautions are as follows:

- Because refrigerants R-12 and R-22 boil at such low temperatures, they may freeze if they are splashed into the eyes or onto the skin. Always wear chemical safety goggles or a full face shield when you work with any refrigerant. Wear along-sleeved shirt and protective gloves.
- Vapors of fluorocarbon refrigerants are four to five times heavier than air and tend to collect in low places. Perform refrigerant detection within 2 feet of the deck and in possible air pockets.
- Refrigeration machinery spaces should be well ventilated, especially when personnel are servicing machinery. Use portable blowers if necessary to keep the refrigerant vapor levels below the TLV of 1,000 ppm.
- Always have two people present when work is being done on refrigeration systems. Use a halide monitor with an alarm so you can be sure refrigerant vapor concentrations in a space do not exceed safe limits.

SEWAGE SYSTEM

In a continuing effort to control pollution of inland and coastal waters, the Navy is installing sewage treatment systems on board naval ships. These marine sanitation systems are composed of three subsystems:

- Flushing water system (provides flushing water)
- Collection system (collects waste)
- Treatment disposal system (treats and disposes of waste)

Sewage discharged by naval ships into rivers, harbors, and coastal waters and the environmental effects of sewage pollution are of great concern to the Navy. In fact, the Navy is required to control sewage

discharge under regulations issued by the Secretary of Defense.

In the past, shipboard sewage has been discharged overboard as a matter of routine design and operation. Studies have shown that concentrations of sewage in inland waters, ports, harbors, and coastal waters of the United States is detrimental to the environment. The Navy has installed marine sanitation devices (MSDs) on ships. The MSDs allow ships to comply with the sewage discharge standards without compromising mission capability.

In 1972, the Chief of Naval Operations (CNO) made the policy decision to install the sewage collection, holding, and transfer (CHT) system aboard naval ships. The CHT system is designed to hold all shipboard sewage that is generated over a 12-hour period. On large ships, this goal can usually be achieved. For smaller ships, the maximum capacity would limit holding time to 3 hours or less, an insufficient time for the ship to transit the 3-mile restricted zone.

The Jered sewage treatment plant and the LHA sewage treatment plant are other types of MSD systems. The Jered sewage treatment plant is designed for a zero liquid discharge. It is capable of using the vacuum-burn principle. Sewage is first collected by a vacuum and then disposed of by incineration. Sewage can be discharged overboard when the ship is at sea or pumped to shore via a connection facility. The LHA sewage treatment plant is a biological sewage treatment process in which sewage and activated sludge can be mixed and aerated. The activated sludge is separated from the treated sewage by sedimentation and discharged or returned to the process as needed.

There are distinct hazards to personnel associated with all sewage systems. These hazards include explosive gases, toxic vapors, and biological contaminants. When operating a CHT system, for example, personnel must be extremely careful so spills do not occur. **ALL SPILLS CAN BE EXTREMELY HAZARDOUS TO PERSONNEL.**

In addition to the removal of CHT contaminants, CHT spills are sanitized with disinfectants so that residual bacteria are eliminated. Medical department personnel must be notified of any CHT *black water* spills. Medical department personnel must also supervise cleanup and sanitation operations in spill areas.

For further information on sanitation systems, refer to *Hull Maintenance Technician 3 & 2*, volume I, NAVEDTRA 10571 (series), chapter 15, and *NSTM*, chapter 593.

SUMMARY

This chapter introduced you to environmental hazards and control. Remember, pollution takes many shapes and forms. Pollution attacks the environment and directly or indirectly affects each of us. Consequently, we must protect the environment by preventing pollution.

On board ship, certain forms of pollution are sometimes difficult to control, such as heat and noise. In these cases, the first line of defense is PROTECTION. In all other cases, we must be concerned with PREVENTION. Keep in mind that prevention of pollution, in any form, is everybody's business. Pollute your environment, and your environment will pollute you.

APPENDIX I

GLOSSARY

AUTOMATIC COMBUSTION CONTROL (ACC) SYSTEM–A system that automatically controls the fuel and air mixture in a boiler.

AUXILIARY MACHINERY–Any system or unit of machinery that supports the main propulsion units or helps support the ship and the crew; for example, pump, evaporator, steering engine, air-conditioning and refrigeration equipment, laundry and galley equipment, and deck winch.

BACK PRESSURE–The pressure exerted on the exhaust side of a pump or engine.

BALLASTING–The process of filling empty tanks with seawater to protect the ship from underwater damage and to increase its stability See DEBALLAST-ING.

BLOW TUBES–Use of steam to remove soot and carbon from the tubes of steaming boilers.

BLUEPRINT–Reproduced copy of a drawing (usually having white lines on a blue background).

BOTTOM DEAD CENTER (BCD)–The position of a reciprocating piston at its lowest point of travel.

BOILER–A strong metal tank or vessel, composed of tubes, drums, and headers, in which water is heated.

BOILER CENTRAL CONTROL STATION–A centrally located station for directing the control of all boilers in the fireroom.

BOILER DESIGN PRESSURE–Pressure specified by the manufacturer, usually about 103 percent of normal steam drum operating pressure.

BOILER INTERNAL FITTINGS–All parts inside the boiler that control the flow of steam and water.

BOILER OPERATING PRESSURE–The pressure at which a boiler is maintained while in service.

BOILER OPERATING STATION–A location from which a boiler is operated.

BOILER RECORD SHEET–A NAVSHIPS form maintained for each boiler, which serves as a monthly summary of operation.

BOILER REFRACTORIES–Materials used in the boiler furnace to protect the boiler from heat.

BOILER ROOM–A compartment containing boilers but not containing a station for operating or firing the boilers Refers specifically to bulkhead-enclosed boiler installations.

BOILER TUBE CLEANER–A cylindrical brush that is used to clean the insides of boiler tubes.

BOILER WATER–The water actually contained in the boiler.

BOTTOM DEAD CENTER (BCD)–The position of a reciprocating piston at its lowest point of travel.

BOURDON TUBE–A thin-walled tube bent into the shape of a letter C, which tends to straighten out when pressure is exerted. As the tube straightens, it moves a pointer around a gauge dial.

BRAZING–A method of joining two metals at high temperature with a molten alloy.

BRINE–A highly concentrated solution of salt in water, normally associated with the overboard discharge of distilling plants.

BRITTLENESS–A property of a material that causes it to break or snap suddenly with little or no prior sign of deformation.

BULL GEAR–The largest gear in a reduction gear train The main gear, as in a geared turbine drive.

BURNERMAN–Person in the fireroom who tends the burners in the boilers.

BUSHING–A renewable lining for a hole through which a moving part passes.

BYPASS–To divert the flow of gas or liquidAlso, the line that diverts the flow.

CALIBRATION–The comparison of any measuring instrument with a set standard of a greater accuracy.

CANTILEVER–A projecting arm or beam supported only at one end.

CAPILLARY TUBE–A slender, thin-walled, small-bored tube used with remote-reading indicators.

CARBON DIOXIDE–A colorless, colorless gas used as a fire-extinguishing agent and for inflating life rafts and life jackets.

CARBON PACKING–Pressed segments of graphite used to prevent steam leakage around shafts.

CASUALTY POWER SYSTEM–Portable cables that are rigged to transmit power to vital equipment in an emergency.

CENTRAL CONTROL STATION (CCS)–The CCS is the main operating station from which a majority of the engineering plant machinery can be controlled and monitored on modern naval ships.

CHECK VALVE–A valve that permits the flow of a liquid in one direction only.

CIRCUIT BREAKER–An electrical device that provides circuit overload protection.

CLUTCH–A form of coupling designed to connect or disconnect a driving or driven member.

COLD IRON–The condition of an idle engineering plant when all port services are received from an external source such as shore or tender.

CONDENSATE–Water produced in the cooling system, of the steam cycle, from steam that has returned from the turbine or from steam that has returned from various heat exchangers.

CONDENSER–A heat-transfer device in which steam or vapor is condensed to water.

CONDUCTION–A method of heat transfer from one body to another when the two bodies are in physical contact.

CONSTANT PRESSURE GOVERNOR–A device that maintains a constant pump discharge pressure under varying loads.

CONTROLLABLE REVERSIBLE-PITCH PROPELLER (CRPP)–A propeller whose blade pitch can be varied to control the amount of thrust in both ahead and astern directions.

CONTROLLER–A device used to stop, start, and protect motors from overloads while the motors are running.

COOLER–Any device that removes heat.

CORROSION–The process of being eaten away gradually by chemical action, such as rusting.

COUNTERSINK–A cone-shaped tool used to enlarge and bevel one end of a drilled hole.

CREEP-RESISTANT ALLOY–A metal that resists the slow plastic deformation that occurs at high temperatures when the material is under constant stress.

CROSS-CONNECTED PLANT–A method of operating two or more systems as one unit.

CURTIS STAGE–A velocity-compounded impulse turbine stage that has one pressure drop in the nozzles and two velocity drops in the blading.

DEAERATING FEED TANK (DFT or DA tank)–A device used in the waste-heat boiler system to remove dissolved oxygen and noncondensable gases from the feedwater.

DEBALLASTING–The process by which seawater is emptied from tanks to protect the ship from underwater damage and to increase its stabilitySee BALLASTING.

DEGREE OF SUPERHEAT–The amount by which the temperature of steam exceeds the saturation temperature.

DIESEL FUEL MARINE–A fuel oil.

DIRECT CURRENT (dc)–current that moves in one direction only.

DIRECT DRIVE–One in which the drive mechanism is coupled directly to the driven member.

DISTILLATE–Water produced in distilling plants.

DISTILLING PLANT–A system that converts seawater into fresh water commonly called evaporators (evaps).

DRAWING–An illustrated plan that shows fabrication and assembly details.

DRUM, STEAM–The large tank at the top of the boiler in which the steam collects.

DRUM, WATER–A tank at the bottom of a boiler.

DUCTILITY–The property possessed by metals that allows them to be drawn or stretched.

ECONOMIZER–A heat-transfer device on a boiler that uses the gases of combustion to preheat the feedwater.

EDUCTOR–A jet pump that uses water to empty flooded spaces.

EFFICIENCY–The ratio of the output to the input.

ELASTICITY–The ability of a material to return to its original size and shape.

ELECTRODE–A metallic rod (welding rod) used in electric weldingIt melts when current is passed through it.

ELECTROHYDRAULIC STEERING–A system having a motor-driven hydraulic pump that creates the force needed to position the ship's rudder.

ELECTROLYSIS–A chemical action that takes place between unlike metals in systems using salt water.

ELECTROMOTIVE FORCE (emf)–A force that causes electrons to move through a closed circuit, expressed in volts.

ELEMENT–A substance that consists of chemically united atoms of one kind.

ENERGY–The capacity for doing work.

ENGINE ORDER TELEGRAPH (EOT)–A device on the ship's bridge that is used to give orders to the engine roomAlso called annunciator.

ENGINEER'S BELL BOOK–A legal record of all ordered main engine speed changes.

ENGINEERING OFFICER OF THE WATCH (EOOW)–officer on duty in the engineering spaces.

ENGINEERING OPERATING STATION (EOS)–

EQUIVALENTS PER MILLION (EPM)–The number of equivalent parts of a substance per million parts of another substanceThe word equivalent refers to the equivalent chemical weight of a substance.

EROSION–A gradual wearing away, such as a gully that is eroded by water.

EVAPORATOR–A distilling device that produces fresh water from seawater.

EXPANSION JOINT–A junction that allows for expansion and contraction.

FATIGUE–The tendency of a material to break under repeated strain.

FEED HEATER–A heat-transfer device that heats the feedwater before it goes to the boiler.

FEEDWATER–Water of the highest possible level of purity made in evaporators for use in boilers.

FERROUS METAL–Metal with a high iron content.

FIREBOX–The section of a ship's boiler where fuel oil combustion takes place.

FIRE MAIN–The saltwater line that provides fire-fighting water and flushing water throughout the ship.

FIRE TUBE BOILER–A boiler in which the gases of combustion pass through the tubes and heat the water surrounding them.

FLAREBACK–A backfire of flame and hot gases into a ship's fireroom from the fireboxCaused by a fuel oil explosion in the firebox.

FLASH POINT OF OIL–The temperature at which oil vapor will flash into tire, although the main body of the oil will not ignite.

FLEXIBLE I-BEAM–An I-shaped steel beam on which the forward end of a turbine is mounted; it allows for longitudinal expansion and contraction.

FLOOR (DECK) PLATES—The removable deck plating of a fireroom or engine room aboard ship.

FLUID–A substance that tends to flow or conform to the shape of a container.

FLUX–A chemical agent that retards oxidation of the surface, removes oxides already present, and aids fusion.

FORCE–Anything that tends to produce or modify motion.

FORCED DRAFT–Air under pressure supplied to the burners in a ship's boiler.

FORCED-DRAFT BLOWERS–Turbine-driven fans that supply air to the boiler furnace.

FORCED-FEED LUBRICATION–A lubrication system that uses a pump to maintain pressure.

FORGING–The forming of metal by heating and hammering.

FRESHWATER SYSTEM–A piping system that supplies fresh water throughout the ship.

FUEL OIL MICROMETER VALVE–A valve, installed at the burner manifold, that controls the fuel oil pressure to the burners.

FUEL OIL SERVICE TANKS–Tanks that provide suction to the fuel oil service pumps for use in the fuel oil service system.

FUSE–A protective device that will open a circuit if the current flow exceeds a predetermined value.

GALLONS PER MINUTE (GPM or gpm)–A unit of measurement.

GAS FREE–A term used to describe a space that has been tested and found safe for hot work (welding and cutting).

GAS GENERATION (GG)–The high-pressure section of the main propulsion gas turbineIt includes the compressor, combustor, high-pressure turbine, front frame, compressor rear frame, turbine mid frame, transfer gearbox, and the controls and accessories.

GAUGE (SIGHT) GLASS–A device that indicates the liquid level in a tank.

GEARED-TURBINE DRIVE–A turbine that drives a pump, generator, or other machinery through reduction gears.

GROUNDED PLUG–A three-pronged electrical plug used to ground portable tools to the ship's structureIt is a safety device that must always be checked before portable electrical tools are used.

HALIDE LEAK DETECTOR–A device used to locate leaks in refrigeration systems.

HANDHOLE–An opening large enough for the hand and arm to enter for making slight repairs and for inspection purposes.

HARDENING–The heating and rapid cooling (quenching) of metal to induce hardness.

HEADER–A large pipe to which smaller pipes are connected so that the liquid may pass freely from one pipe to the other(s).

HEAT EXCHANGER–Any device that allows the transfer of heat from one fluid (liquid or gas) to another.

HERTZ–A unit of frequency that equals 1 cycle per second.

HYDROGEN–A highly explosive, light, invisible, nonpoisonous gas.

HYDROMETER–An instrument used to determine the specific gravity of liquids.

HYDROSTATIC TEST–A pressure test that uses water to detect leaks in closed systems.

IGNITION, COMPRESSION–The heat generated by compression in an internal combustion engine that ignites the fuel (as in a diesel engine).

IGNITION SPARK–The electric spark that ignites the mixture of air and fuel in an internal combustion engine (as in a gasoline engine).

IMPELLER–An encased, rotating element provided with vanes that draws in fluid at the center and expels it at a high velocity at the outer edge.

IMPULSE TURBINE–A turbine in which the major part of the driving force is received from the impulse of incoming steam. See REACTION TURBINE.

INDIRECT DRIVE–A drive mechanism coupled to the driven member by gears or belts.

INERT–Inactive.

INJECTOR–A device that forces a fluid into an area. Injectors are used in the diesel engine to deliver fuel into the cylinders and in boilers to force water into the boilers.

INSULATION–A material used to retard heat transfer.

INTERCOOLER–An intermediate heat transfer unit between two successive stages, as in an air compressor.

JACKBOX–A receptacle, usually secured to a bulkhead, into which telephone plugs or jacks are inserted.

JOB ORDER—An order issued by a repair activity to its own subdivision to perform a repair job in response to a work request.

JP5–A fuel oil similar to DFM.

JUMPER-Any connecting pipe, hose, or wire normally used in emergencies aboard ship to bypass damaged sections of a pipe, a hose, or a wireSee BYPASS.

JURY RIG–Any temporary or makeshift device.

LABYRINTH PACKING–Rows of metallic strips or fins that minimize steam leakage along the shaft of a turbine.

LAGGING–A protective and confining cover placed over insulating material.

LIGHT OFF–To start a tire, as in light off a boiler.

LINE UP–To align a system for operation.

LOGBOOK–Any chronological record of events, such as an engineering watch log.

LOG, ENGINEERING–A legal record of important events and data concerning the machinery of a ship.

LOGROOM–The engineer's office aboard ship.

LUBE OIL PURIFIER-A unit that removes waste and sediment from lubricating oil by centrifugal force.

MACHINABILITY–The ease with which a metal may be turned, planed, milled, or otherwise shaped.

MAIN CONDENSER–A heat exchanger that converts exhaust steam to feedwater.

MAIN DRAIN SYSTEM–A system used for pumping bilges; consists of pumps and associated piping.

MAIN INJECTION (SCOOP INJECTION)–An opening in the skin of a ship through which cooling water is delivered to the main condenser and main lube oil cooler by the forward motion of the ship.

MAKEUP FEED–Water of required purity for use in ship's boilers This water is needed to replace water lost in the steam cycle.

MALLEABILITY–That property of a material that enables it to be stamped, hammered, or rolled into thin sheets.

MANIFOLD–A fitting with numerous branches that directs fluids between a large pipe and several smaller pipes.

MANUAL BUS TRANSFER (MBT)–A device that will transfer electrical power from the normal power supply to an alternate power supply, manually.

MECHANICAL ADVANTAGE (MA)–The advantage (leverage) gained by the use of devices, such as a wheel to open a large valve, chain falls and block and tackle to lift heavy weights, and wrenches to tighten nuts on bolts.

MECHANICAL CLEANING–A method of cleaning the fire sides of boilers by scraping and wire brushing.

MICROMHOS–Electrical units used with salinity indicators to measure the conductivity of water.

MICRON–A unit of length equal to 1 millionth of a meter.

MOTOR GENERATOR SET–A machine that consists of a motor mechanically coupled to a generator and usually mounted on the same base.

NIGHT ORDER BOOK–A notebook containing standing and special instructions from the engineering officer to the night engineering officers of the watch.

NITROGEN-An inert gas that will not support life or combustion.

NONFERROUS METALS–Metals that are composed primarily of some element or elements other than iron (usually nonmagnetic).

OIL KING–A petty officer who receives, transfers, discharges, and tests fuel oil and maintains fuel oil records; certified to test and treat boiler water and feedwater.

OIL POLLUTION ACTS–The Oil Pollution Act of 1924 (as amended), the Oil Pollution Act of 1961, and the Federal Water Pollution Control Act of 1970 prohibit the overboard discharge of oil or water that contains oil, in port, in any sea area within 50 miles of land, and in special prohibited zones.

ORIFICE–A small opening that restricts flow, such as an orifice plate in a water piping system.

OVERLOAD RELAY–An electrical protective device that automatically trips when a circuit draws excessive current.

OXIDATION–The process of various elements and compounds combining with oxygenThe corrosion of metals is generally a form of oxidation; for example, rust on iron is due to oxidation.

PANT, PANTING–A series of pulsations caused by minor, recurrent explosions in the firebox of a ship's boilerUsually caused by a shortage of air.

PARTS PER MILLION (PPM)–Comparison of the number of parts of a substance with a million parts of another substanceUsed to measure the salt content of water.

PITOMETER LOG–Device that indicates the speed of a ship and the distance traveled by measuring water pressure on a tube projected outside the ship's hull.

PLASTICITY–A property that enables a material to be excessively and permanently deformed without breaking.

PREHEATING–The application of heat to the base metal before it is welded or cut.

PRIME MOVER–The source of motion, such as a turbine or an automobile engine.

PUNCHING TUBES–Process of cleaning the interiors of tubes.

PURPLE-K POWDER (PKP)–A fire - extinguishing agent.

PYROMETER–An instrument used for measuring temperatures.

RADIATION, HEAT–Heat emitted in the form of heat waves.

REACH RODS–A length of pipe used as an extension on valve stems.

REACTION TURBINE–A turbine in which the major part of the driving force is received from the reactive force of steam as it leaves the bladingSee IMPULSE TURBINE.

REDUCE–Any coupling or fitting that connects a large opening to a smaller pipe or hose.

REDUCING VALVES–Automatic valves that provide a steady pressure lower than the supply pressure.

REDUCTION GEAR–A set of gears that transmit the rotation of one shaft to another at a slower speed.

REEFER–A refrigerated compartmental authorized abbreviation for refrigerator.

REFRACTORY–Various types of heat-resistant, insulating material used to line the insides of boiler furnaces.

REFRIGERANT 12 (R-12)–A nonpoisonous gas used in air-conditioning and refrigeration systems.

REGULATOR (GAS)–An instrument that controls the flow of gases from compressed gas cylinders.

REMOTE OPERATING GEAR–Flexible cables attached to valve wheels so that the valves can be operated from another compartment.

RISER–A vertical pipe leading off a large horizontal pipe; for example, a fire main riser.

ROTARY SWITCH–An electrical switch that closes or opens the circuit by a rotating motion.

ROTOR–The rotating part of a turbine, pump, electric motor, or generator.

SAE–Abbreviation for the Society of Automotive Engineers.

SAFETY VALVE–An automatic, quick opening and closing valve that has a reset pressure lower than the lift pressure.

SALINITY–Relative salt content of water.

SALINOMETER–A hydrometer that measures the concentration of salt in a solution (brine density).

SATURATION PRESSURE–The pressure corresponding to the saturation temperature.

SATURATION TEMPERATURE–The temperature at which a liquid boils under a given pressureFor any given saturation temperature, there is a corresponding saturation pressure.

SCALE–An undesirable deposit, mostly calcium sulfate, that forms in the tubes of boilers and distilling plants.

SECURE–To make fast or safe-the order given on completion of a drill or exercise. The procedure followed when any piece of equipment is to be shut down.

SENTINEL VALVES–Small relief valves used primarily as a warning device.

SHAFT ALLEY–The compartment of a ship that propeller shafts pass through.

SKETCH–A rough drawing indicating major features of an object.

SLIDING FEET–A mounting for turbines and boilers that allows for expansion and contraction.

SLUDGE–The sediment left in fuel oil tanks, lube oil sumps, and boiler water drums.

SOLID COUPLING–A device that joins two shafts rigidly.

SOOT BLOWER–A soot removal device that uses a steam jet to clean the fire sides of a boiler.

SPECIFIC HEAT–The amount of heat required to raise the temperature of 1 pound of a substance 1$FAll substances are compared to water that has a specific heat of 1 Btu/lb/°F.

SPEED-LIMITING GOVERNOR–A device that limits the rotational speed of a prime mover.

SPEED-REGULATING GOVERNOR–A device that maintains a constant speed on a piece of machinery that is operating under varying load conditions.

SPLIT PLANT–A method of operating an electrical or propulsion plant so that it is divided into two or more separate and complete units.

SPRING BEARINGS–Bearings positioned at varying intervals along a propulsion shaft to help keep it in alignment and to support its weight.

STANDBY EQUIPMENT–Two identical auxiliaries that perform one functionWhen one auxiliary is running, the standby is connected so that it maybe started if the first fails.

STATIC–A force exerted by reason of weight alone as related to bodies at rest or in balance.

STEAMING WATCH–Watches stood when the main engines are in use and the ship is underway.

STEAM LANCE–A device that uses low-pressure steam to remove soot from inside boilers and to remove carbon from boiler tubes.

STEERING ENGINE–The machinery that turns the rudder.

STERN TUBE–A watertight enclosure for the propeller shaft.

STRAIN–The deformation, or change in shape, of a material that results from the weight of an applied load.

STRENGTH–The ability of a material to resist strain.

STRESS–A force that produces or tends to produce deformation in a metal.

STUFFING BOX–A cavity in which packing is placed to prevent leakage between a moving shaft and a fixed part of a valve or pump.

STUFFING TUBE–A packed tube that makes a watertight fitting for a cable or small pipe passing through a bulkhead.

SUMP–A container, compartment, or reservoir used as a drain or receptacle for fluids.

SUPERHEATER–A unit in the boiler that dries the steam and raises its temperature.

SWASHPLATES–Metal plates in the lower part of the steam drum that prevent the surging of boiler water with the motion of the ship.

SWITCHBOARD–A panel or group of panels that distribute electrical power throughout the ship, normally with automatic protective devices.

TAKE LEADS–A method of determining bearing clearance.

TANK TOP–The top side of tank section or double bottom of a ship.

TOP DEAD CENTER (TDC)–The position of a reciprocating piston at its uppermost point of travel.

TEMPERING–The heating and controlled cooling of a metal to produce the desired hardness.

THIEF SAMPLE–A sample of oil or water taken for analysis.

THROTTLEMAN–The person in the engine room who operates the throttles to control the main engines.

THRUST BEARING–A bearing that limits the end play and absorbs the axial thrust of a shaft.

TOP OFF–To fill up a tankA ship tops off its tanks with fuel oil before leaving port.

TORQUE–The force that produces or tends to produce rotation.

TOUGHNESS–The property of a material that enables it to withstand shock as well as to be deformed without breaking.

TRANSFORMER–An electrical device used to step up or step down an ac voltage.

TRICK WHEEL–A steering wheel in the steering engine room or emergency steering station of a ship.

TUBE EXPANDER–A tool that expands replacement tubes into their seats in boiler drums and headers.

TURBINE–A multibladed rotor driven by steam, hot gas, or water.

TURBINE STAGE–One set of nozzles and the succeeding row or rows of moving blades.

TURBINE TURNING GEAR–A motor-driven gear arrangement that Slowly rotates idle propulsion shafts, reduction gears, and turbines.

UPTAKES (EXHAUST TRUNKS)–Large enclosed passages that direct the flow of exhaust gases to the stacks.

VACUUM–A space that has less than atmospheric pressure in it.

VENT–A valve in a tank or compartment that primarily permits air to escape.

VISCOSITY–A liquids resistance to flow.

VOID–An empty, watertight compartment separating other compartments.

VOLATILE–The term that describes a liquid that vaporizes quickly.

VOLTAGE–Electric potential (emf).

VOLTAGE TESTER–A portable instrument that detects electricity.

WATER TUBE BOILER–Boilers in which the water flows through the tubes and is heated by the gases of combustion.

WATER WASHING–A method of cleaning to remove contaminants.

WELDING LEAD–The conductor through which electrical current is transmitted from the power source to the electrode holder and welding rod.

WIPED BEARINGS–A bearing in which the babbitt has melted because of excess heat.

WIREWAYS–Passageways between decks and on the overheads of compartments that contain electric cables.

WORK REQUEST–Request issued to a naval shipyard, tender, or repair ship for repairs.

ZERK FITTING–A small fitting that can be applied to a grease gun to force lubricating grease into bearings or moving parts of machinery.

ZINC–A cheap, renewable metal placed in saltwater systems so that electrolysis will act upon the zinc rather than the ship's structure.

APPENDIX II

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